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GRAYLING MIGRATION AND HABITAT

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RESEARCH PROJECT SEGMENT

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Job No.: R-I-A

Job Title: Population Structure, Migratory Patterns and Habitat Requirements of the Arctic Grayling

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ABSTRACT

Population estimates of grayling greater than 150 mm fork length, conducted on four index sections of the lower 70 miles of the Chena River in 1982 showed declines in three sections from the 1981 estimates. The estimates of 185 and 139 fish per mile for sections 2b and 8a, respectively, represent the lowest (recorded) levels for their areas. Grayling sampled in the four index areas were predominately immature, evidenced by 95 percent being less than 270 millimeter (10.5 in) fork length. Ages II and IV were the dominant age classes, representing nearly 64 percent of the total sample. Age III, normally the dominant age class, accounted for only 12 percent of the total, which may partially explain the low population estimate in the lower river sections. The mean fork length of all four index sections was 186 millimeter. The average yearly mortality for Chena River grayling was 61 percent.

A 1.5-mile-long population index section was established on the Chatanika River. There were an estimated 271 grayling greater than 150 millimeter per mile in this section. An estimate of 426 grayling/mile was also obtained for grayling between 100 and 150 millimeter. The mean length of the 435 grayling sampled was 176 millimeter. As in the Chena, Age II and IV were the dominant age classes, making up 59 percent of the total sample.

Creel census information collected from May 1 to September 15, 1982 along the upper Chena River revealed that an estimated 20,379 angler hours were expended to harvest 12,603 grayling. The estimated catch rate was 0.62 grayling caught and kept per hour. Angler pressure and harvest figures by month, along with catch composition and creel census summary since 1970, are presented.

The grayling intrastream migration study was continued in 1982. Recaptures totaled 142 fish in 1982. Of these, 84 percent were caught in the same area as tagged. Of the 23 fish which showed movement, 12 had moved upstream and 11 had moved downstream.

A survey was conducted on the Charley River in June of 1982. Data on the grayling population structure and stream characteristics are included.

KEY WORDS

Arctic grayling, Tanana drainage, electrofishing, population estimates, creel census, migrations, stock structure, population dynamics, tagging and stream surveys.

BACKGROUND

The Chena River is typical of the clear, rapid-runoff type streams common to interior Alaska. The Chena originates in the Tanana Hills approximately 100 mi east of Fairbanks at lat. 65°N, long. 145°W and flows in a westerly direction, emptying into the Tanana River just below the city of Fairbanks. The entire watershed occupies approximately 1,900 sq mi, with the river basin 100 mi long and a maximum of 40 mi wide. The river has been divided into 17 sections for study (Fig. 1) (Table 1).

The flow of the Chena River at Fairbanks has an annual average of 1,418 cfs based on data collected by the U.S. Geological Survey since 1947. The maximum annual average was 3,160 cfs in 1949 and the minimum was 708 cfs in 1958. The 1967 flood accounted for the record maximum flow of 74,000 cfs through Fairbanks.

Like most clear runoff streams, the Chena River supports a large population of Arctic grayling, <u>Thymallus arcticus</u> (Pallas). While the Chena River contains many species of fish, the grayling is the principal species of recreational importance. Due to its proximity to Fairbanks, the Chena River supports the largest grayling fishery in the state. Table 2 lists common and scientific names of all fish species mentioned in this report.

The Chena Hot Springs Road, which parallels the Chena River from Mile 26 to its terminus at Mile 60, crosses the river seven times, providing easy access for fishermen and recreationists alike. It is in this area of intense fishing pressure that the 1982 creel census was conducted. Also within this area is the 250,000 acre Chena River Recreation Area. Recent campsite construction here by the Alaska Department of Natural Resources, Division of Parks, has increased access to the river and recreational use.

The Department of Fish and Game has monitored angler use and harvest levels on the upper Chena since 1968 (Roguski and Winslow, 1969; Roguski and Tack, 1970; Tack 1971, 1973, 1975, 1976; Hallberg 1977-1982). Use levels have shown a general increase, while catch rates and fish size have remained relatively constant.

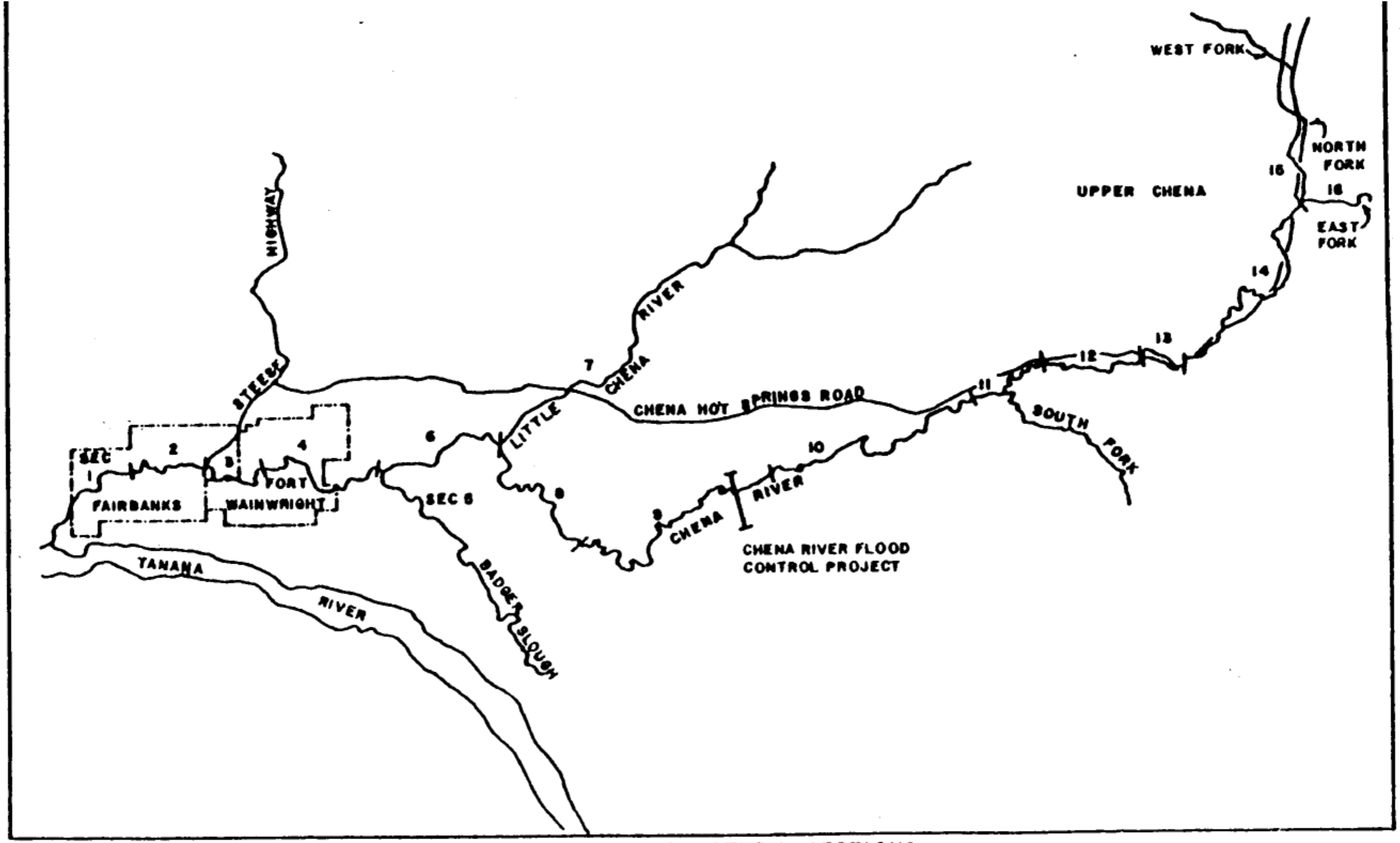

FIGURE I. CHENA RIVER STUDY SECTIONS

Table 1. Chena River study sections.

Section Number	Section Name	River Miles	Section Length Miles
1	River Mouth to University Ave.	0-6	6.0
2a	University Ave. to Peger Road	6-8	2.0
2b	Peger Road to Wendell Street	8-11	3.0
3	Wendell St. to Wainwright Railroad Bridge	11-14.5	3.5
4	Wainwright Railroad Bridge to Badger Slough	14.5-21.5	7.0
5	Badger Slough		16.5
6	Badger Slough to Little Chena	21.5-24.5	3.0
7	Little Chena River		61.5
8	Little Chena to Nordale Slough	24.5-31	6.5
9a	Nordale Slough to Bluffs	31-55.5	24.5
9b	Bluffs to Bailey Bridge	55.5-63	7.5
10	Bailey Bridge to Hodgins Slough	63-79	16.0
11	Hodgins Slough to 90 Mi. Slough	79-90	11.0
12	90 Mi. Slough to First Bridge	90-92	2.0
13	First Bridge to Second Bridge	92-94.5	2.5
14	Second Bridge to North Fork	94.5-102	7.5
15	North Fork of Chena River		35.0
16	East Fork of Chena River		62.0
17	West Fork of Chena River		35.0

Standard mark and recapture methods to estimate grayling numbers were initiated by Roguski and Winslow (1969), and continued by Roguski and Tack (1970), Tack (1971-1976) and Hallberg (1977-1982). Information obtained during the population estimates also includes length frequencies, age and length composition, and annual survival rates, all of which aid in understanding grayling life history and evaluating the health of the exploited stocks of the Chena River.

The U.S. Army Corps of Engineers has constructed a flood control project on the Chena River at river mile 47. The project is designed to channel flood waters from the upper Chena River directly into the Tanana River, bypassing the city of Fairbanks and the lower Chena, thus protecting both from flood waters. Other factors affecting the river include the hot springs and resort on the North Fork, numerous recreation cabins on the North and West Forks, and a military campground near Mullen Slough. Hydraulic gold mining operations are active on the Little Chena River and East Fork, and mining activities are scheduled on the South and West Forks. These activities, along with the problems associated with a city and military complex located in the lower 15 mi of the river, pose a variety of management problems to the Sport Fish Division in our ongoing efforts to maintain the integrity of the Chena River and its fauna.

RECOMMENDATIONS

Research

1. Population estimates on index sections of the Chena River should be continued.

2. Additional population estimates should be performed on index sections on the upper Chena River and the Chatanika River and Salcha Rivers.

3. As an index of recruitment, population estimates of grayling between 100-150 mm should be performed in each index section.

4. Investigations of grayling populations should continue on headwaters of major river systems in the Tanana drainage.

5. Levels and causes of mortality of exploited grayling stocks should be determined. Levels of fishing mortality should be estimated.

6. Tagging studies to determine Arctic grayling movements in the Chena River should be continued and expanded to include Age I and II grayling, and emphasizing movement during spring, fall, and winter.

7. Creel census programs should be continued on the Chena River system with emphasis on obtaining statistically based catch data.

Table 2. Scientific and common names of fish mentioned in this report.

Common Name	Scientific Name and Author	Abbreviation
Arctic grayling	*Thymallus arcticus* (Walbaum)	GR
Burbot	*Lota lota* (Linnaeus)	BB
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
Chum salmon	*Oncorhynchus keta* (Walbaum)	CS
Humpback whitefish	*Coregonus pidschian* (Gmelin)	HWF
Inconnu (sheefish)	*Stenodus leucichthys* (Güldenstadt)	SF
Lake chub	*Couesius plumbeus* (Agassiz)	LC
Least cisco	*Coregonus sardinella* Valenciennes	LCI
Longnose sucker	*Catostomus catostomus* (Forster)	LNS
Northern pike	*Esox lucius* Linnaeus	NP
Round whitefish	*Prosopium cylindraceum* (Pallas)	RWF
Slimy sculpin	*Cottus cognatus* (Richardson)	SSC

8. The grayling population structure in the upper Chena River in the area of heavy fishing pressure should be investigated and compared with unexploited stream sections.

9. Need for stock enhancement in high-use fisheries should be determined.

Management

1. Monitoring of development projects affecting the Chena River should be continued.

2. Assess suitable egg sources and fry rearing areas for possible enhancement of high use grayling fisheries near Fairbanks.

OBJECTIVES

1. To determine Arctic grayling populations and age class structure in index sections of the Chena River.

2. To monitor angler use and harvest of grayling in the upper Chena River adjacent to the Chena Hot Springs Road.

3. To keep abreast of the development projects affecting the fish habitat of the Chena River and other tributaries of the Tanana drainage.

4. To conduct surveys on area streams as time permits. Index sections will be established on the Chatanika River if feasible.

TECHNIQUES USED

Grayling for tagging, population estimates, and age and length composition studies were captured by a boat-mounted electrofishing unit described by Van Hulle (1968) and Roguski and Winslow (1969). Passes were made through each index section on three successive days. Population estimates were made using the Schnabel technique, as described in Ricker (1978).

Grayling 200 mm and greater in length, captured during the population and movements and migration studies, were tagged using a numbered Floy internal anchor tag inserted in the dorsal musculature. Grayling scales used for age determination were individually cleaned and mounted on 20 mil acetate using a Carver press at 20,000 psi, heated to 200°F for 30 seconds. The scales were read on a Bruning 200 microfiche reader.

A roving creel census was conducted along the upper Chena River. Total angler hours were estimated using counts of fishermen at 2 p.m. on six randomly selected days per month within weekend and weekday strata. Interviews were made with anglers contacted during the roving creel census to compute catch statistics and angler profile information. Spot checks of numbers of fishermen and their catch were made on Badger Slough and other early spring grayling fisheries.

FINDINGS

Population Estimates

Chena River:

Mark-recapture population estimates on Arctic grayling in 1982 were conducted on four index sections in the lower Chena River, sections 2b, 8a, "Dam Site" and 10b. Section 2b and 8a both lie below the newly constructed Chena River Lakes Flood Control Project and may be directly impacted during times of flooding. Section 2b lies adjacent to Fairbanks, is easily accessible and has, over the years, been exposed to heavy development. Section 8a is located approximately 15 mi upstream of Fairbanks and, while this area remains fairly accessible, it has not yet experienced intensive development. The upper two sections are located above the flood control structure. The area known as the "Dam Site" is the 3-mi stretch of river directly upstream of the control structure, and it is in this area that flood waters from the Chena River would enter the floodway and eventually find their way into the Tanana River. Estimates here began in 1972 (Tack, 1973) and will be continued to monitor any changes in the grayling population structure as it relates to the flood control project. The last index area, 10b, is undeveloped, relatively inaccessible, and angler utilization is minimal; thus it serves as a control area in our population estimates. A new index area in the upper Chena in the heavily-fished portion of the river will be initiated next year so that population size and age and growth information can be obtained for comparison with catch sample information obtained in the creel census. Results of the 1981 population estimates are presented in Table 3, and a summary of population estimates conducted on the same index sections from 1968 to 1981 appear in Table 4.

The 1982 population estimates show declines from the previous year of 234, 220, and 112 grayling per mi in river sections 2b, 8a, and Dam Site, respectively. There was virtually no change in the estimated grayling population level in section 10b (Table 4).

For the past 5 years grayling population levels in Section 2b had remained relatively constant at about 400 fish per mi after having experienced major declines in the early 1970's (Table 4). It was suspected that grayling levels in the lower Chena were stabilizing at lower levels as the lower river underwent ecological changes associated with sewage diversion (Hallberg, 1981). However, the estimates of 185 and 139 fish per mi for sections 2b and 8a, respectively, represent the lowest recorded population levels for these two areas (Table 4). These low population levels do not have any obvious correlation with any recent development or ecological changes or events. High water levels in 1981 and low summer water levels during previous summers may have had some effect on year class structure, causing lower population estimates. An especially weak Age III year class appeared in 1982. However, this low year class, in itself, is not enough to explain the low population estimates found in sections 2b and 8a.

The upper river population estimates were more in line with past estimates. Although numbers in the "Dam Site" section were down from 1981, the estimate of 371 grayling per mile is very near the past 5-year average of 403 grayling per mile. The estimate of 1,400 grayling per mile in section 10b is slightly higher than the 1981 estimate, even though only 4.4% of the population consisted of Age III fish, a year class which normally contributes at least 30% of the population.

It should be noted that mark-recapture population estimates require that several assumptions be met in order to be accurate. The most important, that a closed population exists, is obviously not met in a river situation. In addition, the confidence intervals around these estimates are quite wide (Table 3) and so should be evaluated only as general indicators of population trends. The sharply lower population levels on the lower Chena, however, indicate a definite decline and emphasize the value of continued index monitoring.

Chatanika River:

A 1.5-mi-long index section was established on the Chatanika River approximately 2 mi below the Elliot Highway bridge. The river is narrow and shallow in this area, making it quite difficult to sample. Tack (1973) performed a population estimate in this same general area. Since then estimates have been attempted but never successfully completed, due mainly to mining siltation.

The 1982 Schnabel mark-recapture estimate for grayling greater than 150 mm was 271 grayling per mile. This is 130 grayling per mile less than the estimate of 1972. If possible, population estimates will continue on a yearly basis to monitor population levels on this important fishery.

As an experiment, a population estimate was performed on Chatanika grayling between 100 and 150 mm fork length. This size group corresponds roughly to Age Class II. If successful, these estimates would provide an index of year class strength for the upcoming Age Class III, which traditionally provides a major portion of grayling in the creel. There were an estimated 426 Age II fish per mile in the Chatanika. The recapture rate was quite low (9 fish) and thus the confidence intervals around this estimate are quite wide. The value of this technique will become apparent in future years when the accuracy of the year class predictions becomes apparent. Based on the success of this Age Class II estimate on the Chatanika, I recommend that these estimates be performed on the Chena River sections as well.

Table 3. Grayling population estimates, catch rates, and catchability estimates for four sections of the Chena River and one section of the Chatanika River 1982. All estimates are for grayling greater than 150 mm fork length except that an additional estimate for grayling 100-149 mm fork length was made on the Chatanika River.

Section (River Mile)	Date of Estimate	Number of Recaptures	Catch Rate Gr/Day	Catchability % Caught/day	Schnabel Estimate Gr/Mi	95% Confidence Intervals for Schnabel Est. (Gr/Mi)
2b (8-11)	July 16-20	26	90	16.2	185	127-283
8a (26-29)	July 13-15	27	71	17.0	139	96-211
Dam Site (46-49)	July 23-27	7	53	4.8	371	180-927
10b (66-69)	July 28-30	15	150	3.6	1,400	847-2,500
Chatanika	Aug. 24-26	64	118	29.0	271	212-346
Chatanika (100-149 mm)	Aug. 24-26	9	47	7.4	426	224-959

Index Sampling Catch Rates

Chena River:

In an effort to simplify index sampling, electrofishing catch rates were evaluated in 1982. Results made it clear that CPUE does not accurately reflect actual population size (Table 3). For example, section 2b, with an estimated population of 185 gr/mi had a catch rate of 90 grayling per electrofishing day. On the other hand, the "Dam Site" section with an estimated 371 gr/mi had a catch rate of only 53 grayling per day (Table 3).

The variability in catch per unit effort is due to differences in catchability (percent of the population captured by a unit of effort) of grayling within different river sections. Catchability is affected by environmental variables such as water velocity, depth and vegetation present. Catchability for the lower river sections, 2b, and 8a, was 16.2%, and 17.0%, respectively. Catchability on the upper river sections, Dam Site and 10b, was 4.8% and 3.6%, respectively (Table 3). The dissimilarity of catchability between the two upper river sections and the two lower river sections undoubtedly reflects environmental differences between the upper and lower river. Catch rate comparisons then, between the upper and lower river will not accurately reflect the population present. However, if catchability within a section proves relatively constant year after year it could be useful as a population trend indicator (Karlstrom, 1976). This would involve only that index counts be made with the electrofishing boat and would require much less effort than the present multiple census mark-recapture population estimates. CPUE will be monitored in future years to evaluate consistency.

Chatanika River:

Comparison of the Chatanika River catch rate with the Chena does not reflect population size based on the Schnabel estimates (Table 3). This again is due to differences in catchability. The catchability estimate of 29% of the population captured for each electrofishing day on the Chatanika was considerably higher than found on the Chena. This is probably because the Chatanika is much narrower than the Chena, making capture more efficient.

For grayling between 100 and 150 mm the catchability was much lower at 7.4% (Table 3). This reflects the lower efficiency of capture of smaller size fish with electrofishing gear. This is the reason that the confidence interval about the population estimate for the smaller fish was much wider than that for the larger fish. Year to year stability of catch rate will be monitored on the Chatanika as well as on the Chena.

Age and Length Structure

Chena River:

Age determinations by scale analysis were made on a subsample of 296 grayling (scales collected from every fifth fish captured) (Table 5).
In the past 4 years Age III fish were the dominant age class, making up an average of 38% of the total population (Table 13). In 1982 only 11.8% of

Table 4. Population estimates for Arctic grayling greater than 150 mm fork length in index sections of Chena River 1968-1982.

River Section	Year	Date	(Schnabel Estimate) Gr/mi
2b	1968		767
	1969		1,323
	1970	July 2-10	1,479
	1971	Aug. 30-Sept. 3	2,095
	1972	June 22-26	978
	1973	July 3-10	679
	1974	July 25-28	642
	1976	July 22-24	596
	1977	July 11-14	479
	1978	July 25-28	254
	1979	July 26-30	316
	1980	July 1-4	463
	1981	Aug. 7-10	419
	1982	July 16-20	185
8a	1979	Aug. 20-23	269
	1980	July 14-17	284
	1981	Aug. 3-6	359
	1982	July 13-15	139
Dam Site	1972	June 27-29	1,306
	1973	July 18-19	800
	1974	July 9-11	416
	1976	Aug. 4-6	464
	1977	July 26-30	437
	1978	Aug. 8-11	495
	1979	July 17-20	261
	1980	July 29-Aug. 1	339
	1981	Aug. 11-14	483
	1982	July 23-27	371
10b	*1970	June 7-July 7	1,873
	1980	Aug. 12-15	1,163
	1981	July 21-24	1,391
	1982	July 28-30	1,400

* The 1970 estimate was conducted on the entire 16 miles of section 10.

Table 5. Age and length composition of 296 randomly sub-sampled grayling in sections 2b, 8a, Chena River Dam Site and 10b, 1982.

Fork Length mm	Age Class I	II	III	IV	V	VI	VII	VIII	Total No.	Length Frequency %
70 - 79	1								1	0.3
80 - 89	2								2	0.7
90 - 99	5								5	1.7
100-109	2								2	0.7
110-119	4	8							12	4.2
120-129	5	22							27	9.4
130-139		19							19	6.6
140-149		18							18	6.3
150-159		16							16	5.6
160-169		5	1						6	2.1
170-179			1						1	0.3
180-189			12	2					14	4.9
190-199			12	18					30	10.4
200-209			5	22					27	9.4
210-219			3	24	2				29	10.1
220-229				20	1				21	7.3
230-239				6	5				11	3.8
240-249				9	3	1			13	4.5
250-259				2	5	1			8	2.8
260-269				1	5	1			7	2.4
270-279				1	4	4			9	3.1
280-289					1	1	2		4	1.4
290-299						1	1		2	0.7
300-309						...	2		2	0.7
310-319						2	1	2	5	1.7
320-329							1	...	1	0.3
330-339								...	0	0
340-349								2	2	0.7
350-359								2	2	0.7
n	19	88	34	105	26	11	7	6	296	
Age Frequency %	6.6	30.8	11.8	33.6	9.0	3.8	2.4	2.1		
$\bar{x}$ fork length (mm)	105.3	136.5	190.2	215.3	250.5	279	304.6	337		

the total population were Age III, ranging from a low of 4.4% in section 10b to a high of 20.7% in section 8a. The lower river sections, 2b and 8a, had higher proportions of Age III fish than did sections 10b and the Dam Site.

It is difficult to say why this normally dominant age group was so low in 1982. This age group represents the 1979 Year Class (year they were spawned). Age class structures in 1980 and 1981 demonstrate the past weakness of this 1979 Year Class. In 1980 only 2% of the population was composed of Age I fish (1979 Year Class) and in 1981 only 12.5% of the population was Age II. These proportions are well below the normal averages of 11% and 31% for Age I and Age II fish, respectively.

The weakness of this 1979 year class indicates that either poor spawning success or very high young-of-the-year mortality occurred. Water discharge in the Chena was about 1.5 times the average during the early summer, May, June and July, of 1979 (USGS, 1979). These high water levels could have affected spawning and hatching success as well as fry survival. Using data from the 3 most recent years, a high correlation was found between numbers of grayling and the rate of water discharge during the spring of their natal year ($r = -0.94$ and -0.80 for Age III and IV fish, respectively). However, these values were not statistically significant ($P>0.05$) due to the small number of years of data available. This correlation will be evaluated as more data become available.

Age II fish were the most abundant age group in three of the index sections, making up almost 31% of the entire 1982 population (Table 5). The relative strength of this 1980 year class was also apparent in 1981 when Age I fish accounted for almost 16% of the population. This is well above the average of 11% for Age I fish. If the strength of this 1980 year class continues into 1983 it should help to improve low population estimates in index sections as well as improve catch rates in the fishery. This is especially important since a very low Age IV year class is expected for 1983.

All 1,476 grayling captured during the index area sampling were measured for length frequency analysis (Table 6). Using only the length frequency it is possible to identify, with reasonable accuracy, the 1 and 2-year-old fish. However, for Ages III and above, there is too much overlap in length to determine age by length frequency (Table 5). When sampled in July, most grayling less than 110 mm are Age I, and most grayling between 110 and 169 mm are Age II. The ability to separate Age II fish on this basis should make it possible to make population estimates on this age class alone to be used as an index of recruitment.

The average length of the sampled grayling in each index area increased steadily from the lower to the upstream sections (Table 6). The difference between the mean fork length in section 2b (171 mm) and 8a (174 mm) was not statistically significant ($P>0.3$). However, the differences in mean fork lengths between all other sections were significant ($P>0.05$), indicating larger and older fish as one moves upstream. This is demonstrated in the length frequencies as well (Table 6).

Table 6. Length frequency (in percent of sample) of 1,476 grayling sampled from four sections of the Chena River and of 435 grayling sampled from the Chatanika River, 1982.

Fork Length mm	River Section 2b	8a	Dam Site	10b	Chatanika
70- 79	...	1.4	...	...	...
80- 89	1.6	3.2	...	...	1.2
90- 99	2.1	1.8	1.7	...	3.0
100-109	1.6	1.8	3.0	0.7	3.6
110-119	1.0	7.1	8.4	3.1	1.9
120-129	2.6	11.0	15.6	6.8	9.0
130-139	10.1	6.0	5.5	9.4	10.0
140-149	18.2	3.6	3.0	5.1	6.3
150-159	14.0	1.4	1.3	2.8	3.2
160-169	4.7	1.1	1.3	1.4	3.7
170-179	3.1	6.0	2.1	0.9	7.4
180-189	5.2	8.2	3.0	3.5	6.7
190-199	7.0	12.1	10.1	7.2	7.4
200-209	9.6	9.3	7.6	10.0	12.0
210-219	6.2	8.5	7.2	10.5	6.3
220-229	5.2	4.6	7.6	8.4	5.6
230-239	3.1	5.0	1.3	6.5	3.9
240-249	2.3	2.8	2.5	5.9	3.2
250-259	0.5	2.1	3.8	3.7	1.9
260-269	1.0	2.1	6.8	4.5	2.1
270-279	0.5	0.4	3.0	3.0	1.2
280-289	0.3	0.4	1.7	2.8	0.7
290-299	...	...	1.7	0.7	0.2
300-309	...	0.4	0.8	1.0	...
310-319	...	...	0.8	1.0	...
320-329	...	...	...	0.3	...
330-339	...	...	...	...	0.2
340-349	...	...	...	0.5	...
350-359	...	...	0.4	0.2	...
n	385	282	237	572	435
Mean Length (mm)	170.7	174.0	187.5	201.8	175.7
Length Range (mm)	81-285	74-302	91-316	106-352	82-334

Table 7. Average fork lengths of grayling sampled from index area population estimates, 1976-1982. Lengths are in milimeters.

Year	Chena River Section			
	2b	8a	Dam Site	10b
1976	201		220	
1977	190		204	
1978	181		183	
1979	178	193	192	
1980	178	186	204	206
1981	177	196	187	178
1982	171	174	188	202

The average fork lengths for the Dam Site (188 mm) and section 10b (202 mm) are similar to past mean lengths (Table 7). Average length in section 2b (171 mm) is down from 1981 (177 mm) and has continually declined since 1976. Average length in section 8a (174 mm) is down 22 mm from 1981 and is well below the average of the last 3 years (192 mm).

The increase in average fork length between sections as one moves upstream is paralleled by an increase in percent of mature fish (>270 mm). Section 2b and 8a contained 0.8% and 1.2% mature fish respectively. The "Dam Site" and section 10b contained 8.0% and 9.5% mature fish, respectively. Obviously, either higher survival in the upper sections or migration of larger fish upstream must account for this occurrence. Tagging and mortality studies are being initiated to attempt to answer this question.

Chatanika River:

Chatanika River grayling age determinations by scale analysis were made from a subsample of 88 fish (scales taken from every fifth fish captured (Table 8). Age distribution was very similar to that of the Chena. Age III fish accounted for 25% of the population, which is less than might be expected. This indicates a below-average year class, although not nearly so low as found in the Chena. As with the Chena, the Age II cohort (1980 age class) was quite strong.

The length frequency for the 435 fish captured during the Chatanika River population estimate is given in Table 6. The length frequency distribution shows no major differences from 1972 (Tack 1973). The mean length of the 435 fish sampled was 176 mm, which is similar to sections 2b and 8a of the Chena. Mean lengths of each age class are slightly lower than found on the Chena. This is especially evident for Age I grayling. A high proportion, (97.7%) of the Chatanika grayling were immature (>270 mm).

<u>Survival and Mortality</u>

Chena River:

Rates of survival and mortality are important determinants of size and age make-up of a population. Added mortality due to fishing can also be a major influence. To evaluate the magnitude and importance of fishing mortality it is first necessary to understand natural mortality rates.

Age frequencies obtained from index sampling in sections 2b, 8a, Dam Site, and 10b for 1980 through 1982 were multiplied by population estimates to obtain per mile estimates of numbers of grayling in each age group (Table 9). These data were used to estimate survival and mortality by two different methods.

The first method (catch curve analysis) compares year class make-up of a population in a single year. This method requires the assumption that each year class begins with an equal number of individuals and that mortality factors remain constant year after year. These two assumption are rarely met. Using this technique, mortality rates of between 11.1% and 56.3% were calculated between 1980 and 1982 (Table 9).

Table 8. Age and length composition of 88 randomly subsampled grayling from the Chatanika River index section, 1982.

Fork Length (mm)	Age Class I	II	III	IV	V	VI	VII	VIII	Total No.	Length Frequency %
80- 89	1								1	1.1
90- 99	2								2	2.3
100-109	2								2	2.3
110-119									...	0
120-129		8							8	9.1
130-139		12							12	13.6
140-149		7							7	8.0
150-159		1							1	1.1
160-169		1	3						4	4.5
170-179			7						7	8.0
180-189			2	1					3	3.4
190-199			4	1					5	5.7
200-209			3	8					11	12.5
210-219			3	3					6	6.8
220-229				5	1				6	6.8
230-239				3	2				5	5.7
240-249				2	2				4	4.5
250-259							1		1	1.1
260-269									...	0
270-279						1			1	1.1
280-289						1			1	1.1
290-299									...	0
300-309									...	0
310-319									...	0
320-329									...	0
330-339								1	1	1.1
n	5	29	22	23	5	2	1	1	88	
Age Frequency %	5.7	33	25	26.1	5.7	2.3	1.1	1.1		
$\bar{x}$ Fork Length (mm)	95	135.1	187.3	215.5	236	280	252	334		

Table 9. Estimated average grayling per mile for each age group for combined Chena River index areas 2b, 8a, Dam Site, and 10b, 1980-1982. Average mortality and survival rate are estimated by two methods.

Age	Year Sampled 1980	1981	1982	Natal Year	Year Class Mortality Est. %	Year Class Survival Est. %
III	194	284	38			
IV	194	65	204	1979		
V	81	92	42	1978		
VI	47	45	25	1977	64.5	35.5
VII	9	12	16	1976	62.4	37.6
VIII	1	6	16	1975	57.0	43.0
				1974	62.7	37.3
				1973	60.0	40.0
Catch Curve						
Mortality Est. %	36.9	56.3	11.1			
Survival Est. %	63.1	43.7	88.9			

The second estimating method follows declines in number of an age class from year to year (cohort analysis) and does not require the assumptions of constant mortality and equal numbers of fish at Age 0. This method provided very consistent average mortality rate estimates. Mortality estimates of between 57% and 64.5% were calculated for the 1973-1977 year classes (Table 9). This method appears to be more accurate than the first and provides a mean mortality estimate of 61.3%. Average yearly survival then would be 38.7%. These estimates will be refined as more data become available (including Age II population estimates, additional yearly population and age class data and more information on the effect of migration out of the study areas). The value of these estimates will increase as the effects of increasing fishing and the necessity for enhancement are evaluated.

Creel Census

Upper Chena River:

Results of the 138-day creel census (May 1-Sept.15) appear in Table 10. During this time a calculated 20,379 angler hours were expended to harvest 12,603 grayling along the upper Chena River above mile 26 of the Chena Hot Springs Road. The estimated catch rate was 0.62 grayling caught and kept per hour.

Fairly constant weather and water conditions probably account for the relatively stable use levels on the Upper Chena River in 1982. This constant pressure resulted in an increase of approximately 5,000 angler hours over the 1981 use level. However, the CPUE fell in 1982 to 0.62 fish per hour, down from the 10-year average of 0.75 fish per hour. This lower catch rate accounted for a decrease in harvest of about 1,000 grayling from the 1981 harvest total.

The two most recent creel censuses have shown that high use and catch levels can occur in May if low water conditions prevail. Breakup in 1982 was not mild and water levels were quite high. The fishing pressure in May, (4,723 angler hours), was similar to the previous 2-year average of 4,832. However, the major effect of the higher water levels in May was seen in the catch rate and resulting harvest. The catch rate in May of 1982 was the lowest of the entire year (Table 10) at 0.51 gr/hour and was well below the previous 2-year average for May of 1.03 gr/hour. The harvest in May of 2,409 grayling reflected the lower catch rate. This 1982 harvest for May was only about half the previous 2-year average of 4,907.

A summary of creel census results since 1970 appears in Table 11. Since 1980 the creel census has included the months of May and September, as the angler hour total of 20,379 reflects. This total is well above that of 1981 which was low due to poor weather, causing light use in late summer 1981 (Hallberg, 1982). The results in Table 11 are not strictly comparable since the dates of creel censuses varied from year to year. For comparison with past years creel census results for June 1-Aug. 31 were calculated (Fig. 2). The angler hour total for June-August 1982 was 14,075. This reflects an increase of 1,300 angler hours over the 8-year average for this

Chena River adjacent to the Chena Hot Springs Road, 1982.

Period	Angler Hours			Grayling Kept Per Angler Hr.	Harvest	Mean Fork Length (mm)
	Weekdays	Weekends	Total			
May	1,687	3,036	4,723	0.51	2,409	266.5
June	2,614	2,376	4,990	0.60	2,994	247.1
July	2,695	2,074	4,769	0.75	3,557	230.0
August	2,138	2,178	4,316	0.54	2,331	266.3
Sept. 1-15	550	1,031	1,581	0.83	1,312	231.3
Total	9.684	10.695	20,379	0.62	12,603	247.9

Angler Composition	(%)
Local Residents	63
Military	18
Tourists	19

Table 11. Summary of creel census results for the upper Chena River, 1970-1982*.

Year	Date	Days	Total Angler Hours	Total Grayling Harvest	Grayling Caught & Kept Per Angler Hour
1970	May 1-31 July 14-Aug. 29	78	12,518	6,770	0.54
1972	May 25-Aug. 27	95	13,116	10,099	0.77
1974	July 01-Aug. 31	62	11,680	18,049	1.55
1975	June 01-Aug. 31	92	22,657	14,067	0.62
1976	June 01-Aug. 31	92	10,762	4,161	0.39
1977	June 01-Aug. 31	92	13,536	9,406	0.69
1978	May 29-Aug. 31	95	10,508	6,898	0.65
1979	June 01-Aug. 31	92	12,744	10,459	0.82
1980	May 08-Sept. 30	144	20,827	16,390	0.78
1981	May 01-Aug. 31	123	15,896	13,549	0.80
1982	May 01-Sept. 15	138	20,379	12,603	0.62

* Data before 1982 taken from Hallberg, 1982.

period of 13,378. However, the June-August 1982 harvest of 8,882 grayling and the CPUE of 0.63 gr/hr were both lower than the previous 10 year averages of 9,323 and 0.77 for harvest and CPUE, respectively.

A partial explanation for the lower catch rate and subsequent harvest for 1982 may be the relative weakness of the Age III year class (Table 12). In the past this year class has provided an average of 40.8% of the fish in the creel. In 1982 only 11.8% of the grayling harvested were Age III. A comparison of age make-up of angler-caught fish and fish taken in the index sampling reflects the weakness of this year class (Table 13). Past creel sampling has shown that Age III and IV fish normally make up the bulk of the fish creeled and that a weak year class can have a significant effect on harvest levels. Assuming an average Age III year class, the harvest level for 1982 would have been approximately 16,500 fish, which is clearly within recorded limits. It is clear that two consecutive low year classes could have a drastic effect on population structure and catch rates. For this reason a method for predicting future strength of the Age III and IV year classes would be very helpful.

The average size of grayling harvested from the fishery was 247.9 mm, which is up from the 6-year average of 227 mm. Again the relatively minor influence of the Age III year class (average size 205 mm) probably was a major reason for the larger average fork length. Fish taken in May averaged about 266.5 mm, which is exactly what they averaged in 1981. About 45% of the 2,409 fish harvested in May were of spawning size (>270 mm). Only 29% of the harvest for the entire summer was larger than 270 mm. This again points out the importance of monitoring the fishery in the early season when a greater proportion of larger and older fish are being captured.

Badger Slough:

Badger Slough is a small, spring-fed tributary of the Chena River. It is close to Fairbanks and provides an extensive early season grayling fishery. In 1981, 4,250 angler days were expended to capture 2,999 grayling in Badger Slough (Mills, 1982). The bulk of the fishing effort occurs during the grayling spawning runs in May.

In May 1982 a spot check creel census was conducted on Badger Slough. Badger Road follows the general course of the slough and 20 counts were made in May by driving the road. An average of 7.1 fishermen were seen per count. A large portion of the slough, however, is not visible from the road and two air counts demonstrated that only about two-thirds of the people actually fishing were seen during the road counts. Because of the inaccuracy of the road counts they cannot be used to estimate angler hours.

During the creel census, 70 fishermen were contacted. Their estimated catch per unit effort was 0.67 grayling per hour. This is slightly higher than the 1982 summer CPUE on the Chena River.

Thirty-one angler-caught grayling were measured and scale samples were taken for aging. The mean length of grayling was 232.3 mm. This is

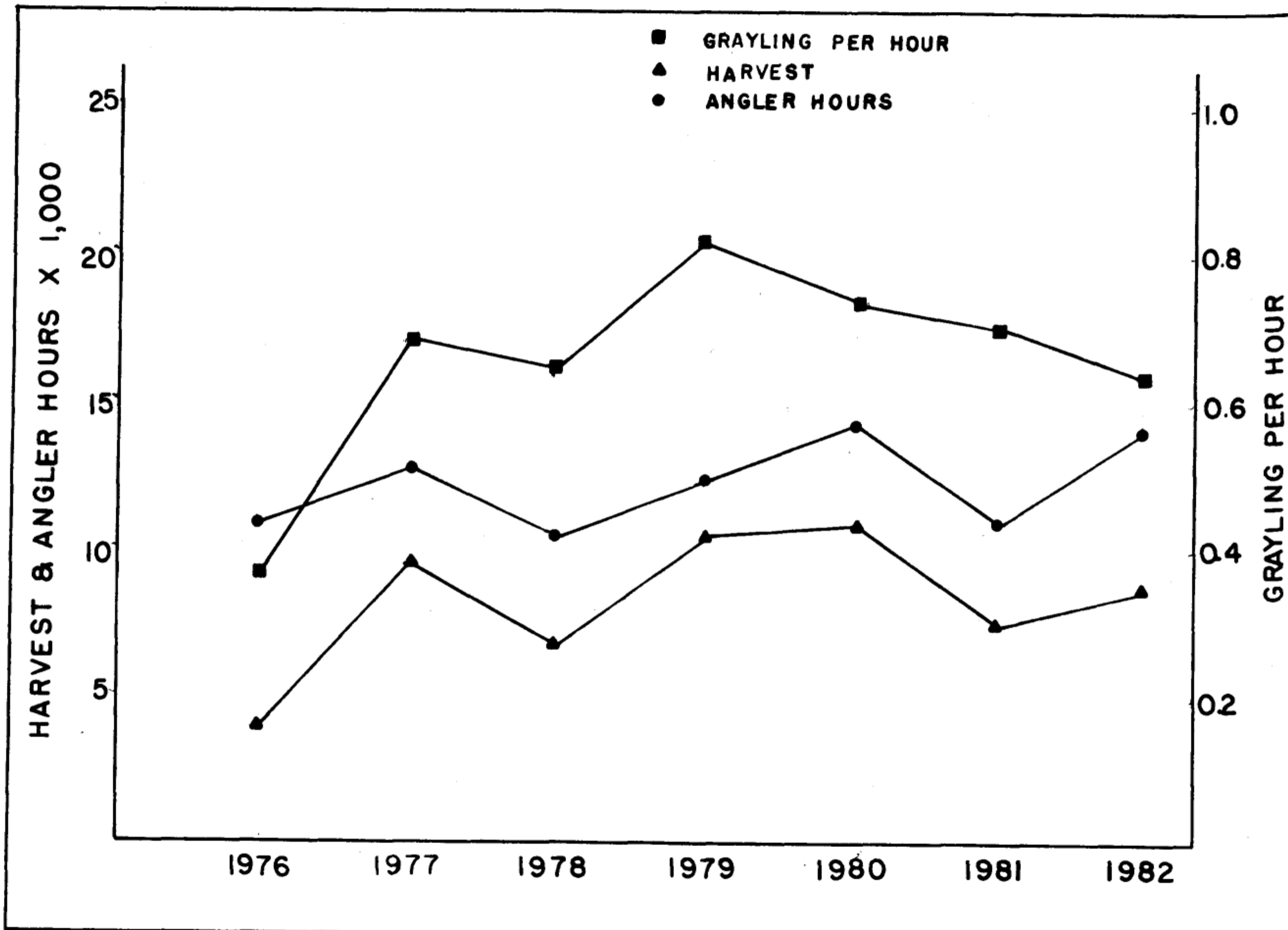

Figure 2. Harvest, angler hours, and catch rate estimates (Gr/Hr) for the upper Chena River grayling fishery June 1 - August 31, 1976-1982.

Fork Length (mm)	Age Class I	II	III	IV	V	VI	VII	VIII	IX	Total No.	Length Frequency %
170-179		3								3	2.2
180-189			2							2	1.5
190-199			3	3						6	4.4
200-209			5	6						11	8.1
210-219			2	11						13	9.6
220-229			2	18						20	14.7
230-239			2	14	1					17	12.5
240-249				8	1	1				10	7.4
250-259				3	2	2				7	5.1
260-269				...	4	3				7	5.1
270-279				2	1	2				5	3.7
280-289					...	8	3			11	8.1
290-299					1	4	...			5	3.7
300-309					1	3	3	3		9	6.6
310-319						1	2	0		3	2.2
320-329							...	1		1	0.7
330-339							2	2		4	2.9
340-349								1		1	0.7
350+									1	1	0.7
n	0	3	16	65	10	24	10	7	1	136	
Age Frequency %	0	22	11.8	47.8	7.4	17.6	7.4	5.1	0.7		
$\bar{x}$ Fork Length (mm)		174	205	226	261	282	307	321	460		

Table 13. Comparison of percent age composition of grayling between creel (hook and line) and index sampling (electrofishing), Chena River 1977-1982.

Age Class	1977		1978		1979		1980		1981		1982	
	Creel	Index	Creel	Index	Creel	Index	Creel	Index	Creel	Index	Creel	Index
I	1	6	2	15	0	11	5.2	2	NA	15.8	0	6.6
II	13	34	22	38	0	20	12	12	NA	12.5	2.3	30.9
III	14	44	61	22	23	46	35	39	NA	39.6	11.8	11.8
IV	22	22	10	20	48	17.5	22	28	NA	12.0	48.1	33.7
V	15	15	2	3.5	15	5	18	13	NA	12.2	7.5	9.0
VI	4	4	0.5	1	6	0.5	5	5	NA	5.7	18.0	3.8
VII	1	1	2.5	0.5	7	0	1.5	1	NA	1.3	7.5	2.1
VIII	0	0	0	0	1	0	1.5	0	NA	0.8	5.3	2.1
IX	0	0	0	0	0	0	0	0	NA	0	0.8	0
n	119	229	115	268	86	218	288	251		384	133	289

slightly lower than the summer average of 247.9 mm for the Chena River. Only 12.9% of the grayling sample were of spawning size (>270 mm). Forty-four percent of the grayling sampled were Age V.

Because of the difficulties associated with angler counts on Badger Slough, I recommend that the Statewide Harvest Study be used for estimates of use and harvest. However, I think that a spot check creel census should be continued in the early summer to monitor yearly changes in catch structure and catch rates, and to provide current information on catch quality.

Tagging Study

This study was initiated in June of 1980 to further our understanding of intrastream movements of grayling in the Chena River. Past information, including age and length frequencies and creel census data, had indicated a general upstream movement of grayling as they grew older. We hoped to learn, through the tagging study, if this upstream movement occurred and if it was important in sustaining catch rates on the upper Chena River.

In 1982, 583 grayling larger than 200 mm were tagged, making a 3-year total of 4,065. In 1982, 142 fish were recaptured, making a 3 year total of 415 or 10.3% of the total marked. As in 1981, the vast majority of the 1982 recaptures (84%) were caught in the same section as marked, showing no apparent movement. Of the 23 recaptures which did show movement, 11 had moved upstream and 12 had moved downstream. The very low proportion of demonstrated movement, as well as the even split between upstream and downstream movement, tends to disprove the hypothesis of upstream migration with increasing age. However, several factors could explain this lack of movement demonstrated by tag returns.

The first complicating factor is that, due to tag size, only fish greater than 200 mm were tagged. This corresponds roughly to Age IV and older fish (Table 5). If the major migration occurs when fish are Age III or less it would not be apparent with our present tagging study. A tagging method for grayling less than 200 mm is being evaluated for next year.

The second factor which might bias the movement results is the method of recapture used. In 1982, 44 tag returns were provided by anglers and 98 came from the electrofishing index studies. Since the index sampling is done in the same areas every year, fish that didn't move would have a greater chance of being recaptured than those that did move. Ninety-eight percent of the fish sampled during the index runs had not moved. However, only 52% of the angler recaptures showed no movement. Direction of movement of angler recaptures was split almost equally between upstream and downstream directions. It appears that the angler returns give a more accurate indication of movement then do the index sampling returns.

In 1980, 2,250 fish were tagged in June. These fish may have been tagged before the completion of their post-spawning upstream migration which would tend to promote a bias in recaptures upstream from the area of tagging. This was especially apparent in the 1980 recapture sample. In 1982, 50 grayling were recaptured that had been tagged in June of 1980. These fish were much more likely to have shown movement (36%) than the 92 recaptures which had been tagged in July or August (5.4%). As expected, the June-tagged fish also showed a definite upstream movement bias. Of those showing movement, 61% moved in an upstream direction, whereas only 20% of the movement of fish tagged in July and August was upstream.

The final source of bias is the time of recapture (Table 14). Fish recaptured in the spring could be in the process of the upstream post-spawning or post-overwintering migration, while fish caught in the fall could be in the process of a downstream overwintering migration. Only fish caught in July or August can be expected to be inhabiting their normal summer areas. As expected, in 1982 90% of the recaptures from July and August had not moved, whereas only 42% of the recaptures from other times of the year were recaptured in the same area as tagged.

In 1983, in an effort to standardize recapture methods, I will make a week-long electrofishing recapture run of the entire river. This should overcome the problems mentioned of time and method of recapture, and should provide us with a better understanding of what movements are occurring.

River Surveys

Charley River:

An 85-mile stretch of the Charley River from above Copper Creek to its confluence with the Yukon River was surveyed in late June of 1982. The major purpose of the float trip was to obtain a representative sample of the grayling population structure of the relatively unexploited Charley River for comparison with the more heavily fished Chena River.

Based on observations and measurements during the float trip I divided the Charley into three sections for comparison. Section I starts at river mile 84 and continues downstream approximately 20 miles to Copper Creek. The river in this section is generally confined to a single 150-foot-wide channel in a steep canyon. The river bottom is mostly large cobble and boulders. The water velocity in the main current averaged about 5 mph and the gradient was quite steep, dropping an average of 38.5 feet per mile. In the Copper Creek area, the river dropped 55 feet per mile. The river banks in this upper area were well scoured and no sweepers were present. This section does not correspond well to any part of the Chena River.

Section II continues downstream approximately 25 miles from section I. The river is still confined to the canyon but the average width of the river has increased to approximately 200 feet and the velocity has slowed to 2.7 mph. The streams now drops approximately 25 feet per mile. The bottom composition is mainly large gravel and the average depth has increased, with many more pools present. Section II is similar in many respects (including gradient and velocity) to the upper tributaries of the Chena, (i.e. West, North, East and South Forks).

Section III continues downstream for 35 miles to the mouth. Here the valley becomes broader and the stream begins to meander with numerous, cutbanks, sweepers, and gravel bars. The bottom is mostly small gravel with some muddy areas. The average width is approximately 250 feet and the water velocity averages 2.2 feet per second. The river drops 12 feet per

Table 14. Movement summary of tagged grayling in the Chena River, 1982.

Month	No. Fish Tagged	No. Fish Recaptured	No. Moved Upstream	$\bar{x}$ Distance Traveled Upstream (mi)	No. Moved Downstream	$\bar{x}$ Distance Traveled Downstream (mi)	No Apparent Movement
April	0	1	0	...	1	65	0
May	0	2	0	...	2	22.5	0
June	0	7	2	17.5	1	7	4
July	583	103	2	12.5	2	7.5	99
August	0	20	6	12.7	2	11.5	12
Sept.	0	10	2	28.5	3	35.7	5

mile. This lower stretch of the Charley River is similar to the upper Chena River adjacent to the Chena Hot Springs Road. No areas of the Charley are analogous to the lower Chena, which is much slower, deeper, and more meandering than any areas of the Charley.

Fish sampling, both by hook and line and gill net, was hampered by extremely high and muddy water encountered during the early days of the float trip. In stream Section I 28 fish were caught, only five of which were caught in gill nets. The fish ranged from 259-425 mm in length and the averaged length was 352 mm. In section II, only eight fish were captured, three of which were gill net captures. These fish ranged from between 223-360 mm and averaged 281 mm. In Section III, 12 grayling were sampled, two of which were captured in gill nets. These fish ranged from 238-402 mm and averaged 326 mm. One northern pike and eight longnose suckers were also captured in gill nets in Section III.

The expectation that average length and age would increase from the lower to the upper river did not take place. The lowest average length (281 mm) was found in the middle section of the Charley. However, average length and age in the upper, faster water section was greater than either of the lower two sections. Obviously, much larger sample sizes will be needed to draw meaningful conclusions concerning age and length distribution.

The age length distribution of all grayling captured is shown in Table 15. A comparison with the Chena River creel census samples (Table 5) clearly shows a higher proportion of older fish in the unexploited Charley. The most common age class was Age VII with 29%. Average fork length at each annulus is also greater on the Charley than on the upper Chena, however, the age distribution, as well as average length, of the Charley River fish is quite similar to that found in the headwater tributaries of the Chena (Hallberg, 1977). Sample sizes of Charley River fish are much too small to determine if these similarities are due to habitat similarities or because very little fishing occurs in either area. Hopefully electrofishing samples can be taken in the future to provide a larger and more accurate indication of the age structure of the Charley River.

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Table 15. Age and length composition of 48 grayling sampled by hook and line and gill net from the Charley River, 1982.

Fork Length (mm)	Age Class III	IV	V	VI	VII	VIII	IX	X	Total No.	Length Frequency %
220	1								1	2.1
230	...	1							1	2.1
240	1	3							4	8.3
250		1							1	2.1
260			1						1	2.1
270			1						1	2.1
280			1	1					2	4.2
290				1					1	2.1
300				1	1				2	4.2
310				2	1				3	6.3
320				2	5	1			8	16.7
330				...	3	...			3	6.3
340				1	1	...			2	4.2
350					2	...			2	4.2
360				1	1	1	1		4	8.3
370						...	1		1	2.1
380						1	2		3	6.3
390						...	...		...	0
400						1	3		4	8.3
410						1	1		2	4.2
420							1	1	2	4.2
n =	2	5	3	9	14	5	9	1	48	
Age Frequency %	4.2	10.4	6.3	18.8	29.2	10.4	18.8	2.1		
$\bar{x}$ Fork Length (mm)	232	247	275	318	333	377	397	420		

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